February 28, 2007

Joe Karkoski
Regional Water Quality Control Board
11020 Sun Center Drive #200
Rancho Cordova, California 95670-6114

Dear Mr. Karkoski:

Public Solicitation of Water Quality Data and Information for 2008 Integrated Report – List of Impaired Waters and Surface Water Quality Assessment [303(d)/305(b)]

The California Department of Fish and Game (Department) has jurisdiction over the conservation, protection and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of those species (Fish and Game Code Section 1802). As trustee agency for fish and wildlife resources we are responsible for providing, as available, biological expertise to review and comment on environmental documents and impacts arising from Project activities, as well as, propose protections to sustain healthy populations of fish and wildlife.

The Department has prepared the attached document to identify an emerging issue and to initiate discussions regarding water bodies that do not meet (cool) temperature water quality standards to protect anadromous fish beneficial uses within the San Joaquin River and its three main tributaries, the Merced, Stanislaus and the Tuolumne rivers. All four rivers are currently identified in relevant water quality control plans, as providing beneficial use for salmon and rainbow trout including anadromous steelhead (i.e., spawning, rearing, and migratory habitats). Collectively for the San Joaquin River, Chinook salmon populations have declined and currently only provide 36% of the San Joaquin River population objectives[1]. Individually, current salmon adult escapement abundance for the Stanislaus, Tuolumne and Merced rivers, respectively, is only 39%, 26%, and 50% of targeted population goals. As result of these low populations levels, the salmon escapement populations in the Stanislaus, Tuolumne, and Merced rivers are in poor condition. There are many factors, including water temperature levels and regimes that contribute to this status.

[1] Based on the State Water Resources Control Board Narrative Doubling Goal for the San Joaquin River as stated in the San Francisco/Sacramento-San Joaquin River Delta Estuary Water Quality Control Plan using the 1967 to 1991 25 year escapement average of 18,312 (per Doubling makes it 36,624) as compared to the 1992 to 2006 average of 13,221.

The Department believes that one critical factor limiting anadromous salmon and steelhead population abundance is high water temperatures which exist during critical life-stages in the tributaries and the main-stem. This results largely from water diversions, hydroelectric power operations, water operations and other factors. Herein, we present water temperature results collected from the San Joaquin River (1971 through 2006), Stanislaus River (1999 through 2005), Tuolumne River (1998 through 2006), and Merced River (1997 through 2005), in support of our concern that elevated water temperatures are impairing San Joaquin Basin fishery beneficial uses and commonly exceeding the "cool" water quality standards within the relevant Section 208 Water Quality Control Plans.

Elevated water temperatures appear to be a factor in the continued decline in adult salmon escapement abundance in the San Joaquin, Stanislaus, Tuolumne, and Merced rivers, either by: i) inducing adult mortality as adults migrate into the San Joaquin River, and tributaries, to spawn (i.e., pre-spawn mortality); ii) reducing egg viability for eggs deposited in stream gravels, iii) increasing stress levels and therefore reducing survival of juveniles within the tributary nursery habitats, and iv) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta. For rainbow trout, potentially including anadromous steelhead, excessively warm water temperatures have the potential to limit trout population abundance by restricting juvenile and adult resident over-summer rearing habitat to very short stream reaches, due to downstream thermal regimes. As such, too few miles of suitable habitat may exist to sustain healthy population levels.

We want to point out that throughout this report we have referred to the Environmental Protection Agency (EPA) published temperature standards and used the data reporting metrics normally utilized by the EPA (seven-day average of daily maximum temperatures) for displaying temperature standard exceedance.
We believe these criteria and metrics can be enhanced by the further inclusion of duration-of-exposure and other information. As such, for each affected salmon and steelhead life stage, we are developing a duration-of-exposure analysis (actual percent of time, within particular Julian weeks, in which various temperature ranges are exceeded). We believe this may help further clarify the metabolic demand (i.e., stress) placed on the fisheries by elevated water temperatures, and may relate directly to questions of thermal and fishery beneficial use impairment. Thus, you should anticipate receiving that important supplemental information from us and others. We do recognize that other parties may also have important scientific results which should be considered in the evaluation of thermal impacts within these waters, and we encourage the Regional Board to consider any such additional information.

The Department has included two copies of the attachments for the Regional Water Quality Control Board; one with color figures and tables, and another in black and white for photocopy reproductions. If you have any questions or comments regarding this manuscript please contact Dr. Andrew Gordus, Staff Environmental Scientist, at the above letterhead address or by telephone at (559) 243-4014, extension 239.

Sincerely,

W. E. Loudermilk
Regional Manager

Attachment

cc: Carl Wilcox
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Temperature Water Quality Standards for the Protection of Anadromous Fish in the Stanislaus River, Merced River, Stanislaus River, Tuolumne River and the San Joaquin River

The Department proposes to discuss temperature water quality standards to protect cold water salmonid fisheries beneficial uses for the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers (Table 1) (Figure 1). For the San Joaquin River, the control point is Vernalis (Table 1). River mile points for various locations in the San Joaquin River, Stanislaus, Tuolumne, and Merced Rivers are provided in Tables 3 through 6. Temperature threshold levels are those identified by the U.S. Environmental Protection Agency (EPA 2003) (Table 2).

Table 1. San Joaquin, Stanislaus, Tuolumne, and Merced River water quality standard locations and temperature thresholds.

River	Location	River Mile	Season	Life Phase	Threshold (ºC)	Affected River Miles
San Joaquin	Vernalis	72	9/1 - 10/31	Adult/Egg	18	118[1]
	Vernalis	72	3/15 - 6/15	Smolt	15	118
Stanislaus	Mouth	0	9/1 - 10/31	Adult/Egg	18	58
	Riverbank	33	10/1 - 12/15	Egg	13	33
	Mouth	0	3/15 - 6/15	Smolt	15	58
Tuolumne	Mouth	0	9/1 - 10/31	Adult/Egg	18	52
	Waterford	28	10/1 - 12/15	Egg	13	24
	Mouth	0	3/15 - 6/15	Smolt	15	52
Merced	Mouth	0	9/1 - 10/31	Adult/Egg	18	52
	River Mile 28	28	10/1 - 12/15	Egg	13	24
	Mouth	0	3/15 - 6/15	Smolt	15	52

[1] Distance (118 miles) is from Merced River confluence to the San Joaquin River and the San Joaquin-Sacramento River confluence in the Delta.

Insert
Figure 1. Lower San Joaquin River Basin.

Table 2. EPA temperature thresholds for Pacific migratory salmonid species and life stages.

Salmonid Life History Phase Terminology	EPA-based Recommended Temperature Thresholds to Protect Salmon and Trout[1] (Criteria are based on the 7-day average of the daily maximum values)
Adult migration	<64°F (<18°C) for salmon and trout migration
	<68°F (<20°C) for salmon and trout migration - generally in the lower part of river basins that likely reach this temperature naturally, if there are cold-water refugia available [but no evidence of such refugia are available for the Stanislaus River]
Incubation	<55°F (<13°C) for salmon and trout spawning, egg incubation, and fry emergence
Juvenile rearing (early year)	<61°F (<16°C) for salmon "core" juvenile rearing - generally in the mid- to upper part of river basins
Smoltification	<59°F (<15°C) for salmon smoltification
	<57°F (<14°C) for steelhead smoltification (for composite criteria steelhead conditions are applied)
Juvenile rearing (late year)	<64°F (<18°C) for juvenile salmon and steelhead migration plus non-Core Juvenile Rearing - generally in the lower part of river basins

[1] Water temperature thresholds taken from: United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp. April. The EPA identified temperature unit is: Seven day average of the daily maximum water temperature (7DADM).

Table 3. San Joaquin River mile points from the confluence of the Sacramento River confluence to the Merced River confluence.

Site Name	River Mile
Vernalis	72
Stanislaus River Confluence	75
Tuolumne River Confluence	85
Merced River Confluence	120

Table 4. Stanislaus River mile points from the confluence of the San Joaquin River to the Goodwin Dam.

Site Name	River Mile
Goodwin Dam	58
Knights Ferry	54
Orange Blossom Bridge	45
Oakdale Rec. Area	40
Riverbank	33
Caswell	9
San Joaquin River Confluence	0

Table 5. Tuolumne River mile points from the confluence of the San Joaquin River to the La Grange Dam.

Site Name	River Mile
La Grange Dam	52
Basso Bridge	47
Turlock State Recreation Area	42
Waterford	32
Fox Grove	26
Shiloh	4
San Joaquin River Confluence	0

Table 6. Merced River mile points from the confluence of the San Joaquin River to the Crocker-Huffman Dam.

Site Name	River Mile
Crocker-Huffman Dam (Merced Hatchery)	52
G Street Bridge	46
Hwy 59 Bridge	42
River Mile 31	31
River Mile 12	12
River Mile 1	1
San Joaquin River Confluence	0

Adult Chinook salmon migration season

Adult fall-run Chinook salmon (*Oncorhynchus tshawytscha*) migrate upstream through the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers from approximately Julian week 36 through 43 (i.e. September 1st through October 31st). The overall mean maximum weekly temperature across years for the four rivers was above the maximum threshold (18° C) for all weeks, except week 43 (Tables 7, 8, 9, and 10). The area of impaired river during this same period ranged from 40 to 84 percent of a river's length (Tables 7, 8, 9, and 10). In most years, the last two weeks of

the primary migration season had suitable (cool) water temperatures for the adult salmon, except the San Joaquin River, which 41% of the last two weeks was impaired (Table 10).

Spawning/Egg Incubation Season

The Chinook salmon spawning/egg incubation season in the Stanislaus, Tuolumne, and Merced Rivers occurs from approximately Julian week 40 through 50 (i.e. October 1st through December 15th). The overall mean maximum weekly temperatures across years were above the maximum threshold (13° C) for weeks 40 through 46 for the Stanislaus River (Table 11) and for the Tuolumne River (Table 12) and through week 48 on the Merced River (Table 13). The Merced River had warmer temperatures for longer periods into the season, as well as, had higher temperatures compared to the other two rivers. The area of impaired river miles on the Stanislaus during this same period ranged from 4 (16%) to 25 (100%) miles of the river's length; whereas for the Tuolumne and Merced Rivers the number of impaired river miles ranged from one (4%) to 24 (100%) miles on the Tuolumne River, and from 3 (13%) to 24 (100%) miles on the Merced River. The period of time water temperatures are too warm for this life stage is more than two-thirds of the spawning season and includes up to 100% of the available habitat in any given year.

Smoltification for the Three Main Eastern Tributaries

The Chinook salmon smoltification period in the Stanislaus, Tuolumne, and Merced Rivers occurs from approximately Julian week 11 through 24 (ie. March 15th through June 15th). The overall mean maximum temperature across all years is above the maximum threshold (15° C) for 13 of the 14 week period on the Stanislaus River (Table 14), weeks 18 through 24 on the Tuolumne River (Table 15) and throughout the entire period on the Merced River (Table 16). Overall impaired habitat is approximately 2 (3%) to 52 (100%) miles of a river's length across all weeks and years (Tables 14, 15, and 16). Thus, the second half of this life-stage season is above the threshold temperature for smoltification/smolt survival for the Tuolumne River and for the entire season on the other two rivers.

Smolt Outmigration Season

Chinook salmon smolt outmigrate in all four rivers occurs from approximately Julian week 11 through 24 (ie. March 15th through June 15th). Habitat temperature requirements on the three tributaries for smolt migration are similar as for smoltification which was presented in the previous section. The smolt migration temperature threshold on the San Joaquin River is 18°C. Similar to the conditions for the three tributaries discussed above, the second half of the migration season has water temperatures above this threshold (Table 17), with impairment occurring over half of the available habitat.

Steelhead Summer Rearing Season

The steelhead rainbow trout (*Oncorhynchus mykiss*) summer rearing season in all three eastern tributaries occurs from approximately Julian week 24 through 37 (ie. June 15th through September 15th). The Stanislaus River's weekly temperatures were above the threshold (18° C)

during the middle of the rearing season (Table 18). The remaining overall mean maximum weekly temperatures across years were at or slightly below (0.4 to 2.5 degrees) the threshold across the season (Table 18). For the Tuolumne and Merced Rivers, the entire rearing season maximum mean temperatures were above the threshold the entire season (Tables 19 and 20), with the Merced River having the warmest temperatures compared to the other two rivers. The area of impaired river during this life stage ranged from one to ten miles (8 to 100 percent) of the Tuolumne and Merced River's length (Tables 19 and 20).

Summary

Water temperatures were too warm (>18° C) approximately three-quarters of the time Chinook salmon are migrating upstream during the fall months in all four river systems. One-third to three quarters of the habitat had unsuitable water temperatures for migrating adult salmon. Warm water temperatures can decrease dissolved oxygen in the water and can act as a barrier to migration. Approximately 70 to 100 percent of the spawning/ incubation season had water temperatures above the threshold (>13° C) in the three eastern tributaries. Similar to migrating adult salmon, one-third to three-fourths of the habitat does not provide optimal habitat for egg incubation and fry emergence. Increased water temperatures can decrease the availability of dissolved oxygen to the eggs, decrease egg hatchability, and decrease the survival of fry once they emerge from the eggs. On the Stanislaus and Merced Rivers, smoltification water temperatures (>15°C) were too warm 100% of the season during most years. On the Tuolumne River water temperatures are too warm during the second half of the season. Warm temperatures can decrease, inhibit, or reverse the physiological function or events of smoltification, as well as, decrease available oxygen to the smolt. Over 50 percent of the smolt migration season had water temperatures above the threshold (>18° C). Similar to adult migrants, warm water temperatures can act as a barrier to migrating smolts moving downstream, decrease physiological function and growth, and decrease dissolved oxygen availability to the fish.

Steelhead require appropriate water temperatures on a year-round basis in the four rivers, particularly the three eastern tributaries. We evaluated the rearing period for this report because this is considered the most critical life stage/period for steelhead survival. The other time periods overlap with Chinook salmon, which if salmon water temperatures are met, by default, steelhead water temperatures criteria will also be met. Tuolumne River and Merced River water temperatures were very warm (>18° C) 100% of the time for three and five, respectively, of the 6-year study period. The Stanislaus River had warm water temperatures 50 percent of the rearing season which occurred during the middle of the season. As stated above for salmon, increased water temperatures decrease dissolved oxygen, decrease physiological function and growth of the fish.

In summary, water temperatures in all four river systems are too warm for anadromous fish during all four of their life stages. Elevated water temperatures cause premature adult mortality as adults migrate into the river system to spawn (i.e. pre-spawn mortality); cause reduced egg viability for eggs deposited in redds; and reduce smolt out-migration survival as smolts leave the nursery grounds and migrate through the eastern tributaries and San Joaquin River to the Delta.

Raw Data and the Quality Assurance Project Plan

All raw data is presented in Appendices A, B, C, and D and an electronic copy (in Excel) is provided on the CD as file name Merced River Temperature.xls; Stanislaus River Temperature.xls; Tuolumne River Temperature.xls; and Vernalis River Temperature.xls. All the summary tables are presented in the worksheet tabs with the word "summary". Two format versions are provided: one with color and the other with shading for photocopying. The remaining tabs represent "raw" data as presented in Appendices A through D. Figure1 is on a separate CD with files Figure 1.doc (color version) and Figure 1bw.doc (black and white version).

The Quality Assurance Project Plan (QAPP) is presented in Appendix E and on the CD (file name FinalProjectPlan.doc with four additional "pdf" format file maps of the four rivers).

References

Deas, M., Bartholow, J., Hanson, C., Myrick, C. 2004. Peer review of water temperature objectives used as evaluation criteria for the Stanislaus – lower San Joaquin River water temperature modeling analysis.

Marston, Dean D. 2003. Stanislaus river water temperature criteria development and application for chinook salmon and steelhead. DFG Publication to Cal-Fed Sponsored Stanislaus Water Temperature Objectives Peer Review Panel Proceedings.

Myrick, C.A., and J.J. Cech, Jr. 2001. Temperature effects on chinook salmon and steelhead: a review focusing on California's Central Valley populations. Bay-Delta Modeling Forum Technical Publication 01-1

United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp.

Report Preparation

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Software used to prepare this manuscript: Microsoft Word and Excel.

Certification:

I certify and attest that to the best of my knowledge, this report contains an accurate and complete account of the assessment activities undertaken by the Department of Fish and Game.

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Andrew Gordus, Ph. D. Date
Staff Environmental Scientist

Summary Tables 7 through 20.

Appendix A. Raw water temperature data for the Stanislaus River.

Appendix B. Raw water temperature data for the Tuolumne River.

Appendix C. Raw water temperature data for the Merced River.

Appendix D. Raw water temperature data for the San Joaquin River.

Appendix E. Quality Assurance Project Plan

Lower San Joaquin River Basin-Wide Water Temperature Modeling
Project Data Collection Protocol

Add report here on separate CD because too large to attac h to this file.